

CLAIMS

We claim:

1 1. A slurry for chemical mechanical polishing (CMP) of a structure including a
2 refractory metal based barrier film and a dielectric film, comprising:
3 a plurality of composite particles and at least one selective adsorption additive, said
4 composite particles including an inorganic core surrounded by a shell including said selective
5 adsorption additive, wherein said selective adsorption additive is substantially adsorbed by said
6 dielectric film but not substantially adsorbed by said refractory metal based barrier film.

1 2. The slurry of claim 1, wherein said inorganic cores comprise at least one selected
2 from the group consisting of silica, zirconia, yttria, titania, silicon nitride, silicon carbide and
3 alumina.

1 3. The slurry of claim 1, wherein said inorganic cores are multiphase particles, said
2 multiphase particles comprising a first material coated with at least one other material.

1 4. The slurry of claim 1, wherein a surface of said inorganic cores is selected to be
2 chemically equivalent to said dielectric layer.

1 5. The slurry of claim 3, wherein said other material is selected to be chemically
2 equivalent to said dielectric layer.

1 6. The slurry of claim 3, wherein said inorganic cores are at least one selected from
2 the group consisting of silica, doped silica and nanoporous silica.

1 7. The slurry of claim 3, wherein said other material comprises at least one selected
2 from the group consisting of silica, nanoporous silica and doped silica.

1 8. The slurry of claim 3, wherein said inorganic cores are at least one selected from
2 the group consisting of alumina, zirconia, silicon nitride and said other layer is at least one
3 selected from the group consisting of silica, doped silica and nanoporous silica.

9. The slurry of claim 1, wherein said selective adsorption additive exhibits substantial adsorption to said dielectric layer, said dielectric film selected from the group consisting of silicon dioxide, silicon nitride and low K materials.

10. The slurry of claim 1, wherein said selective adsorption additive exhibits adsorption to a copper or silver containing film greater than adsorption to said refractory metal based barrier film.

11. The slurry of claim 1, wherein a selectivity of a CMP process using said slurry is at least approximately 20 for said refractory metal based barrier film compared to said dielectric film, said dielectric film comprising a silicon dioxide or low K film.

1 12. The slurry of claim 1, wherein a selectivity of a CMP process using said slurry is
2 at least approximately 100 for said refractory metal based barrier film compared to said dielectric
3 film, said dielectric film comprising a silicon dioxide or low K film.

1 13. The slurry of claim 1, wherein a selectivity of a CMP process using said slurry is
2 at least 0.5 for said refractory metal based barrier film compared to a layer comprising copper or
3 silver.

1 14. The slurry of claim 1, wherein a selectivity of a CMP process using said slurry is
2 at least 2.0 for said refractory metal based barrier film compared to a layer comprising copper or
3 silver.

1 15. The slurry of claim 1, wherein a selectivity of a CMP process using said slurry is
2 at least approximately 100 for a layer comprising copper or silver compared to said dielectric
3 film, said dielectric film comprising a silicon dioxide or low K film.

1 16. The slurry of claim 1, wherein a selectivity of a CMP process using said slurry is
2 at least approximately 1000 for a film comprising copper or silver compared to said dielectric
3 film, said dielectric film comprising a silicon dioxide or low K film.

1 17. The slurry of claim 1, further comprising at least one organic solvent.

1 18. The slurry of claim 1, further comprising at least one passivating additive for
2 inhibiting the oxidation of a copper or silver containing film.

1 19. The slurry of claim 18, wherein said passivating additive comprises at least one
2 selected from the group consisting of benzotriazole (BTA), tolytriazole (TTA), imidazole, thiols,
3 mercaptans, oxalic acid, sodium hexanoate and carboxylic acid.

1 20. The slurry of claim 1, further comprising at least one complexing agent.

1 21. The slurry of claim 20, wherein said complexing agent comprises at least one
2 selected from the group consisting of acetic acid, citric acid, tartaric acid and succinic acid.

1 22. The slurry of claim 1, wherein said selective adsorption additive comprises at least
2 one surfactant selected from the group consisting of non-ionic, anionic, cationic and zwitterionic
3 surfactants.

1 23. The slurry of claim 1, wherein said selective adsorption additive comprises at least
2 one surfactant selected from the group consisting of SAS, SDS, CTAB, CTAC,
3 TRITON X-100®, TWEEN-80®, AND KETJENLUBE 522®.

1 24. The slurry of claim 1, wherein said selective adsorption additive comprises CTAB
2 or CTAC, and said inorganic cores comprise silica.

1 25. The slurry of claim 24, wherein said CTAB comprises C₁₂TAB.

1 26. The slurry of claim 25, wherein said oxidizer is at least one selected from the
2 group consisting of hydrogen peroxide, potassium ferrocyanide, potassium iodate, and
3 perchlorates.

1 27. The slurry of claim 22, wherein a concentration of said surfactant is from 0.1 of a
2 bulk CMC of said solution to 1000 said CMC.

1 28. The slurry of claim 22, wherein a concentration of said surfactant is from 0.5 of
2 said CMC to 100 times of said CMC.

1 29. The slurry of claim 1, wherein said selective adsorption additive comprises at least
2 one polymer.

1 30. The slurry of claim 29, wherein said polymer is at least one selected from the
2 group consisting of polyethylene oxide (PEO), polyacrylic acid (PAA), polyacryamide (PAM),
3 polyvinylalcohol (PVA) and polyalkylamine (PAH).

1 31. The slurry of claim 1, further comprising at least one salt.

1 32. The slurry of claim 31, wherein said salt is at least one selected from the group
2 consisting of chlorides, nitrates and ammonium-based salts.

1 33. The slurry of claim 1, wherein a pH of said slurry is from 6 to 13.

1 34. The slurry of claim 1, wherein a pH of said slurry is from 8 to 11.

1 35. The slurry of claim 1, wherein a concentration of said core particles in said slurry
2 is from approximately 1% to 40% by weight.

1 36. The slurry of claim 1, further comprising at least one oxidizer.

1 37. The slurry of claim 36, wherein said oxidizer is at least one selected from the
2 group consisting of hydrogen peroxide, potassium ferrocyanide, potassium iodate and
3 perchlorates.

1 38. The slurry of claim 1, wherein said slurry provides adsorption ratio (AR) for a
2 film comprising copper or silver of no more than 5, said refractory metal based barrier film of no
3 more than 5, and said dielectric film of at least 10.

1 39. The slurry of claim 38, wherein an AR of said dielectric film is at least 100.

1 40. The slurry of claim 38, wherein an AR of said dielectric film is at least 500.

1 41. The slurry of claim 1, wherein said slurry provides an adsorption ratio (AR) for a
2 film comprising copper or silver of no more than 2, said refractory metal based barrier film of no
3 more than 2, and said dielectric film of at least 10.

1 42. The slurry of claim 41, wherein an AR of said dielectric film is at least 100.

1 43. The slurry of claim 41, wherein an AR of said dielectric film is at least 500.

2 44. The slurry of claim 1, wherein said slurry provides a selective adsorption ratio
3 (SAR) for a film comprising copper or silver to said refractory metal based barrier film of at
 least one.

1 45. The slurry of claim 1, wherein said slurry provides a SAR of said dielectric film to
2 said refractory metal based barrier film of at least 50.

1 46. The slurry of claim 1, wherein said slurry provides a SAR of said dielectric layer
2 to said refractory metal based barrier film of at least 100.

1 47. A slurry for chemical mechanical polishing (CMP) of a structure including a
2 refractory metal based barrier film and a dielectric film, wherein said slurry provides a selectivity

3 for a CMP process of at least approximately 50 for said refractory metal based barrier film
4 compared to said dielectric film, said dielectric film comprising a silicon dioxide or low K film.

1 48. A slurry for chemical mechanical polishing (CMP) of a structure including a
2 refractory metal based barrier film, copper film and a dielectric film, wherein said slurry provides
3 a selectivity for a CMP process of at least approximately 100 for said copper film compared to
4 said dielectric film, said dielectric film comprising a silicon dioxide or low K film.

1 49. A method for chemical mechanical polishing (CMP) a structure which includes a
2 refractory metal based barrier film and a dielectric film, comprising the steps of:

3 providing a slurry including a plurality of composite particles and at least one selective
4 adsorption additive, said composite particles including an inorganic core surrounded by a shell
5 including said selective adsorption additive, wherein said selective adsorption additive is
6 substantially adsorbed by said dielectric film but not substantially adsorbed by said refractory
7 metal based barrier film,

8 applying said slurry to said structure, and
9 removing said refractory metal based barrier film using a polishing pad.

1 50. A method for chemical mechanical polishing (CMP) a structure which includes a
2 refractory metal based barrier film and a dielectric film, comprising the steps of:

3 providing a slurry including a plurality of composite particles and at least one selective
4 adsorption additive, said composite particles including an inorganic core surrounded by a shell

5 including said selective adsorption additive, wherein said selective adsorption additive is
6 substantially adsorbed by said dielectric film but not substantially adsorbed by said refractory
7 metal based barrier film,
8 applying said slurry to said structure, and
9 removing said refractory metal based barrier film using a polishing pad, wherein said
10 method provides a selectivity of at least approximately 50 for said refractory metal based barrier
11 film compared to said dielectric film, said dielectric film comprising a silicon dioxide or low K
12 film.

51. A single step chemical mechanical polishing (CMP) process for polishing a structure which includes a gate or interconnect metal film, a refractory metal based barrier film and a dielectric film, comprising the steps of:

4 providing a slurry including a plurality of composite particles and at least one selective
5 adsorption additive, said composite particles including an inorganic core surrounded by a shell
6 including said selective adsorption additive, said refractory metal based barrier film and said gate
7 or interconnect metal film not substantially adsorbing said selective adsorption additive, said
8 dielectric film substantially adsorbing said selective adsorption additive;
9 applying said slurry to said structure, and
10 removing overburden regions of said gate or interconnect metal film and then removing
11 overburden regions of said refractory based barrier film using a polishing pad in a single
12 polishing step.

1 52. The method of claim 51, wherein a selectivity of said gate or interconnect metal
2 film to said dielectric film is at least 100, a selectivity of said gate or interconnect metal film to
3 said refractory based barrier film is at least 1 and a selectivity of said refractory based barrier
4 film to said dielectric film is at least 100.

1 53. The method of claim 51, wherein a selectivity of said gate or interconnect metal
2 film to said dielectric film is at least 100.

1 54. The method of claim 51, wherein said gate or interconnect metal film comprises
2 copper or silver, and alloys thereof.

55. The method of claim 51, wherein said inorganic cores are multiphase particles,
said multiphase particles comprising a first material coated with at least one other material.

56. The method of claim 51, wherein a surface of said inorganic cores is selected to
be chemically equivalent to said dielectric film.

1 57. The method of claim 51, wherein said slurry comprises at least one passivating
2 additive for inhibiting the oxidation of a copper or silver containing film.

1 58. The method of claim 57, wherein said passivating additive comprises at least one
2 selected from the group consisting of benzotriazole (BTA), tolytriazole (TTA), imidazole, thiols,
3 mercaptans, oxalic acid, sodium hexanoate and carboxylic acid.

1 59. The method of claim 58, wherein a concentration of said passivating additive is
2 from 1 mM to 1 Mole.

1 60. The method of claim 51, wherein said slurry comprises at least one complexing
2 agent.

1 61. The method of claim 60, wherein said complexing agent comprises at least one
2 selected from the group consisting of acetic acid, citric acid, tartaric acid and succinic acid.

1 62. The method of claim 51, wherein said selective adsorption additive comprises at
2 least one surfactant selected from the group consisting of non-ionic, anionic, cationic and
3 zwitterionic surfactants.

1 63. The method of claim 51, wherein said selective adsorption additive comprises at
2 least one surfactant selected from the group consisting of SAS, SDS, CTAB, TRITON X-100®
3 and TWEEN-80®, and KETJENLUBE 522®.

1 64. The method of claim 51, wherein said slurry comprises a salt, said salt being at
2 least one selected from the group consisting of NH₄Cl and NH₄NO₃, NaCl and KCl.

1 65. The method of claim 62, wherein a concentration of said surfactant is from 0.1 of
2 a bulk CMC of said solution to 1000 of said CMC.

1 66. The method of claim 51, wherein said selective adsorption additive comprises at
2 least one polymer.

67. The method of claim 51, wherein said slurry includes at least one organic solvent.

68. The method of claim 51, wherein said slurry comprises at least one salt.

69. The method of claim 51, wherein a pH of said slurry is from 6 to 13.

1 70. The method of claim 51, wherein said slurry comprises at least one oxidizer.

1 71. The method of claim 70, wherein said oxidizer is at least one selected from the
2 group consisting of hydrogen peroxide, potassium ferrocyanide, potassium iodate, and
3 perchlorates.